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#### ABNORMAL BONE QUALITY AND MICRO ARCHITECTURE IN AIS

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Adolescent Idiopathic Scoliosis (AIS) is a complex three-dimensional (3D) spinal deformity of unknown etiology. It mostly occurs in girls between 10 and 16 years old with a prevalence of 2 to 3% worldwide. AIS could be a disabling condition associated with significant morbidities. It is important to elucidate the pathophysiology and etiology of AIS so that effective prophylactic and therapeutic measures could be devised.

The etiology of AIS is believed to be multi-factorial and around one-third of AIS girls demonstrated low bone mass. Dual-energy X-ray Absorptiometry (DXA) has been used in previous studies showing the association between AIS and osteopenia the degree of which was correlated with curve severity. Low bone mass has been reported to be present as a systemic phenomenon at the hip, spine and other peripheral sites including the distal tibia, radius and os calcis in a significant percentage of AIS patients. Furthermore, osteopenia could persist longitudinally into adulthood in AIS.

Although DXA has generated important information on the profile that characterized AIS, it has the limitation of being a projectional integrated areal-BMD (aBMD) and thus cannot differentiate between cortical and trabecular bone. Our group has further reported lower volumetric BMD with peripheral quantitative computed tomography (pQCT) study and noted reduced bone volume fraction and trabecular bone thickness with low osteocyte and osteoblast density in a pilot histomorphometric study in AIS. Quantitative Ultrasound (QUS) study also demonstrated significantly lower Broadband Ultrasound Attenuation (BUA) and Stiffness Index (SI) at the non-dominant os calcis in AIS girls, suggesting the possibility of altered bone micro-architecture in AIS. Recently, our group has also shown that SI is a significant and independent prognostic factor for curve progression in AIS after adjusting for age, puberty and curve severity. It is logical to hypothesize that low BMD, abnormal cortical and trabecular bone geometry and micro-architecture could play an important role in the etiopathogenesis of AIS.

In contrast to QUS which can only provide indirect assessment of bone mineral densities and bone quality, the high-resolution peripheral quantitative computed tomography (HR-pQCT) can offer non-invasive measurement of bone structural and mechanical indices including bone geometry, volumetric BMD (vBMD) and bone micro-architecture at the trabecular and cortical compartment separately, without being confounded by bone size. This presentation will give an overview and summary of the evolution of our serial studies on the bone density, bone micro-architectural parameters as well as cortical and trabecular bone quality and bone strength indices in AIS patients versus normal matched controls.

#### Brief CV

**Research Area(s):** Adolescent Idiopathic Scoliosis, Paediatric Orthopaedics

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#### INFLUENCE OF ANTHROPOMETRIC PARAMETERS ON ASSESSMENT OF PEDIATRIC BONE MINERAL DENSITY AND BONE MINERAL CONTENT

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The goal of this study was to assess the implication of including relevant anthropometric variables in the creation of reference curves for areal bone mineral density (aBMD) and bone mineral content (BMC) in pediatrics.

Analysis of the dual-energy X-ray absorptiometry (DXA) data collected as part of the Bone Mineral Density in Childhood Study<sup>1</sup>, including 2012 boys and girls, 5–22 y old, with a total of 10,525 visits, resulting in aBMD and BMC observations at the lumbar spine, hip (neck and total), forearm and whole body (total body and total body less head). Multivariate statistics were used to rank order the influence of the independent variables age, gender, race (black/non-black), height, weight, percent body fat (%fat) and sexual maturity. Two different models were created for each aBMD and BMC parameter, the practical model containing age, gender, race, height and weight as well as the full model, adding %fat. We compared the number of subjects that fell below 2 standard deviations in our models with those below the same limit of the currently standard LMS model<sup>2</sup>, which is based on age, sex and race, and of the height adjusted Z-scores<sup>3</sup>.

Between 50% and 82% of subjects identified as below normal (<–2 SD) based on the LMS model were not classified as being below normal in our practical model. Using the full model, misclassification increased for all aBMD and BMC parameters, ranging from 49% to 92%. Height-adjusted Z-scores reduced the misclassifications to 33–60% in comparison to the practical model and to 41–73% in comparison to the full model. For both the practical and the full model, misclassifications in comparison to the LMS model were worse for BMC than for BMD at all sites with the exception of the femoral neck. Considering that BMC is more heavily influenced by bone size than BMD, inclusion of body height and weight in the model reclassifies small, under-weight subjects away from the lower tail of the distribution, which is not done by the LMS model, as this model takes care of body size only through the surrogate of age.

The traditional comparison of pediatric BMD and BMC data against age-, sex- and race-matched controls can be refined if anthropometric parameters are taken into account.

(Sponsored by the National Institute for Child Health and Human Development)

#### Brief CV

**Research Area(s):** Characterizing Bone Growth through maturation. Micro-pixel edge detection. Finding objects smaller than instrument resolution. Quantitative Bone Analysis. CT. DXA. Image Processing Technique.

**Technical Expertise:** Quantitative bone analysis from instrumentation development to image analysis to population characterization. Software streamlining and optimization.

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#### PATIENT TRANSLATIONAL MOTION CORRECTION FOR REDUCTION OF ARTIFACTS IN A FAN-BEAM CT SCANNER

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